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Agriculture Development Fund

FINAL REPORT

GUIDE FOR CULTIVATOR CONVERSION

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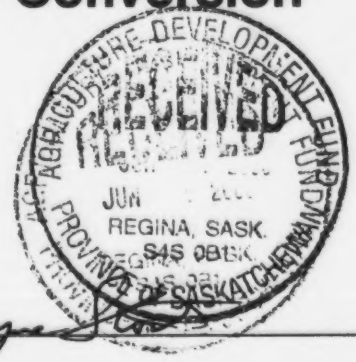
Final Report

Guide for Cultivator Conversion



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Acknowledgement

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1. Introduction

In the herb industry there are differences of opinion on whether cultivating between the rows of crop is good or bad. The herb industry is relatively new to the prairies and herbs are often the first true row crop that prairie farmers have grown. Some people in the herb industry prefer to grow a cover crop between the rows that they will later mow down, while others prefer to mechanically control weeds. In both cases, either due to the organic requirement for herb production or due to a lack of registered herbicides, often some between row cultivation is required.

When it comes to tillage some farmers prefer the small single row tillers or three-point hitch equipment more commonly found in market gardens, while others would like to have access to a larger cultivator.

The goal of this project was to develop a guide for those who wish to convert an older style of field cultivator for use in tillage when row cropping. Used, drawn equipment is more widely available on the prairies than three-point hitch equipment, so the guide focuses on the conversion of drawn equipment.

2. Project Scope

Herb growers in Saskatchewan were contacted to gather information on their use of tillage equipment and to find older cultivators that had been converted into row crop machines.

This search lead to Charlie Coleman, one herb grower in Manitoba that had converted older cultivators for use as row crop tillage machines, and some others. Converted cultivators were observed in operation and as well the procedure for converting older cultivators into row crop tillage tools was investigated.

The results are included in this report and are in a guide that has been published and is available to interested producers through PAMI's information distribution system.

3. Project Procedure

3.1 Selection of a Cultivator

No one make of machine is necessarily better suited to conversion than another. A grower has to assess their own situation as to crops, conditions, tractor to be used, availability of a second operator, etc. and then evaluate the available cultivators to determine how well suited they are for conversion.

3.1.1 Cultivator Position

Cultivators can be either drawn, front mounted or three-point hitch mounted.

Drawn Cultivators: Hitch movement and the length of the drawbar and hitch allow side to side movement of the cultivator. This can be of use if guide wheels are used as it allows the machine to move slightly to line up with the rows. Another advantage is that hitch modification is not needed so it reduces the complexity of modification.

They have the disadvantage that the tillage location is far behind the tractor operator position so it is hard to detect damage to plants that is occurring and it is difficult to anticipate minor steering changes needed to prevent this problem. This leads to the need for a second person to ride on the cultivator to make the needed adjustments to positioning as the cultivator moves and it necessitates changes to the cultivator or tractor hitch to allow this side to side steering to be done.

Three-point Hitch Mounts: Many prairie farmers do not have three-point hitch equipped tractors but for those who do this is an option. The three-point hitch attachment position allows for development of a closer coupled unit and places the tillage tool closer to the tractor operator to improve visibility and provide more positive control. The cultivator will now follow the tractor directly, which has advantages during straight row travel. As long as alignment of crop rows and the tractor is correct the cultivator should be in the correct location; however, on turning, the movement of the tractor front wheels can be amplified at the rear of the cultivator particularly if the cultivator is long. As such, the shorter the cultivator length the better with these systems and depending on row space, a single or double rank machine may be the best.

Front Mounted (Push Style): Mounting the cultivator in front of the tractor and pushing it would provide the tractor operator good visibility and maneuverability while cultivating (**Appendix I - Figure 1**). This should eliminate an additional guidance system and the need for a second person. This location is not the traditional location for a pulled machine, but when one thinks of a push blade or bucket on the front of a tractor, the concept appears to have merit, especially for the smaller size of older cultivators.

Two concept drawings (**Appendix I - Figure 1** and **2**) have been included to show some possibilities. Further work needs to be done on this idea in order to recommend the best approach to take on the design. Either a push pole or a three-point lift device on the front of the tractor could be used to control the cultivator. The effective width that could be handled may be a function of tractor weight, as heavy forces from stones applied to the outer end of the cultivator may push the tractor around.

3.1.2 Step One – Row Spacing

Determine the row space requirements for the crops you are growing and will grow. Obviously the shanks have to be moveable to match your row spacing requirements. Will the crop fill in towards the centre of the rows, and how much will you need to adjust the shank or tool width to accommodate this growth? Would a knock-on style opener by justified? The crop row spacing may need to be altered in the middle of the machine to accommodate your tractor tire spacing (**Appendix I - Figure 3**). This spacing may also be affected by your seeding equipment. Do you use a single row seeder or multiple row seeder with matching spacing to the cultivator? If the row crop cultivator will be used for seeding, by adding a seed box on top, then tillage shanks with a seed opener should be installed where desired. This arrangement could also be used for marking rows when seeding one row at a time. The tillage shovels could be moved to the location of the seed rows and they could be used for marking the field **(Appendix I - Figure 4)**.

3.1.3 Frame Size or Layout

Cultivators were originally designed to work the soil at row spaces of 12 in. or less, with a full set of shovels. Therefore, frame size or strength shouldn't play a big role because in row cropping you will be using at most only 2/3 of the shanks. Therefore, all the shanks and trips don't need to be in good shape.

Plugging between the shanks shouldn't be a problem with the wider row spacing and row crop so either a three or four rank machine should be fine. In some row crop cases a double rank or even single rank tool bar can be used. Frame to ground clearance may be a consideration if you are tilling a tall crop such as is often the case with multi-year herb crops **(Appendix I - Figure 5).**

Frame width will be a consideration depending on topography, machine leveling and whether it is drawn or mounted on the tractor. Tractor hp available will also affect frame width. Tool type, cultivation depth and ground speed needed will all affect hp requirements **(Appendix II).**

3.1.4 General Considerations

Following are considerations for machine selection:

1. How easy is the machine to level front to back and side to side, and are all the adjustments still working?
2. Are the remaining shanks still fairly tight especially sideways so they don't wander into the crop?
3. Ease of movement of the shanks, including sliding from side-to-side and removal and replacement on the frame, are major considerations especially if you are working in different crops and row spacings.
4. How heavy are the shanks? Lighter shanks may wander more due to side stone impact or when a shank is working against a soil ridge.

3.2 Cultivator Guidance

Cultivator guidance is an area where the biggest problems occur but also where there are many possible solutions. When the cultivator is towed behind the tractor there is some lag time and some difficulty ensuring tillage up to and not into the growing crop. A single operator on the tractor has a difficult time trying to accomplish this. This is why some form of guidance system is often used to get close to the crop and reduce the need for hand weeding. Tractor mounted cultivators whether front or rear mounted must be guided by tractor steering. Simple pointer type markers attached to the tractor can be used to assist the driver in this process. The following is a description of other different types of control available for use with a towed cultivator.

3.2.1 Manual System using Guide Wheels

This is the type of system that is usually found on market garden equipment and because it is usually used on three-point hitch equipment, it is unknown how well they would actually work on drawbar drawn equipment, but in principle there is no reason they wouldn't work well. These systems use guide wheels that guide the cultivator by riding in guide furrows or against ridges usually made at seeding. These systems allow the cultivator to move sideways, in relation to the tractor, within the limits of the hitch. By leaving the drawbar free to swing, the tractor just pulls the cultivator and is only used to guide it in the general direction. It's unknown what effect rocks or wind and rain erosion would have on guide wheel performance with a towed cultivator, as this was not observed in operation. This system may be more suited to crops that are harvested yearly rather than crops that require a 2 or 3 year growing cycle as ridges due to seeding or furrows will tend to be less prominent as each season passes and provide less direction to the cultivator while erosion, plant roots and other factors will be more prevalent over time. (**Appendix I – Figures 6** and **7**).

3.2.2 Hydraulic Guidance with Operator Assist

Charlie Coleman in Manitoba and row crop farmers in the United States have adapted and used variations of this system with tow behind cultivators. A second person sitting on the cultivator operates a hydraulic valve, which controls a cylinder that moves the swinging draw bar left and right, moving the cultivator to accommodate closer tillage to the crop (**Appendix I - Figure 8**).

The modification consists of a hydraulic cylinder mounted underneath the tractor approximately halfway between the draw pin and the front mounting pin on the drawbar. The cylinder rod end is located on the drawbar where the cylinder stroke in and out is matched to or greater than the sideways swing of the drawbar. The back of the cylinder is then located on a mount which is perpendicular to the draw bar when it is straight back. A hydraulic 2-way valve is quick coupled into one of the remote circuits. The hydraulic valve must be matched to either the open centre or closed centre system of the tractor. A standard 4 in. ag cylinder with 8 in. stroke will work fine. A flow control valve on the hydraulics may be required to reduce the speed of the cylinder to eliminate any drawbar whipping. The cultivator operator, by operating the valve, steers the cultivator to ensure proper tillage location. A layout of the system is outlined in **Appendix I - Figure 9**. The hydraulics required for this system would cost ≈ $300 plus cost of hoses.

When using this system it's easiest for the cultivator operator to line up the cultivator with a marker located above one row than it is to line up a shank with a buried shovel close to the crop. A disk cultivating near the crop would be easier to keep on line as it is visible. The marker can be anything that hangs above one row of crop to aid in positioning. The seat on the cultivator could be located at the rear of the cultivator for safety and ease of operation with this system. The tractor operator then only has to concentrate on keeping the tractor between the rows. With these systems there is always some hazard to the operator from dust, falling under the machine or potential injury due to shank breakage. This risk should be minimized by use of seat belts, care in location of the seat and the wearing of a suitable dust mask.

3.2.3 Automatic Guidance Systems

This type of system eliminates the operator riding on the cultivator as described in the previous section. The automatic guidance system has sensors to control the movement of the cultivator by either moving the hitch or by steering the tractor. These systems could also be used for guidance during seeding.

One style of unit consists of wire or plastic wands that run along the soil surface near the base of the plant (**Appendix I - Figure 10**). These wands attach to the pivot point that operates a micro switch when the wands rotate as they come in contact with the crop. This sends a signal to a hydraulic cylinder that steers the unit. Residue, protruding dirt or weed growth can compromise accurate row crop sensing.

Another system uses a sensor mounted at the front of the cultivator that straddles the crop, controlling the direction by sensing changes in the dirt height near the crop row. Sophisticated systems allow you to adjust the sensitivity so the system doesn't overreact to foreign obstacles.

None of the mentioned guidance systems, manual or automatic, has been tested or observed in operation by PAMI, therefore, PAMI can't judge their quality of operation or reliability or recommend their use. A producer should investigate cost, performance and reliability before committing to a purchase of these systems. For manufacturers addresses see **Appendix III**.

4. Summary and Conclusion

Most older cultivators are suitable for modification for row cropping. An individual farmer must determine his needs by the crops he is growing and tractor power available. This guide can be used to make one aware of the decisions that are required to be made while selecting a machine.

While certainly drawn cultivators can be modified for three-point hitch or front attachment and there may be advantages to do so, there are no readily available examples to demonstrate this and a certain amount of trial and error work should be anticipated by anyone attempting it. Towed cultivators have been adapted and there is more available experience with towed cultivators. This method has been the focus of this guide.

The requirement of a guidance system is something that needs to be addressed by the individual farmer. Options are discussed in this report.

6. Equipment

No equipment has been purchased for the project.

7. Project Public Information Materials

A guide was published in April 2000 and is attached in **Appendix IV**.

APPENDIX I

Appendix I

Project Figures

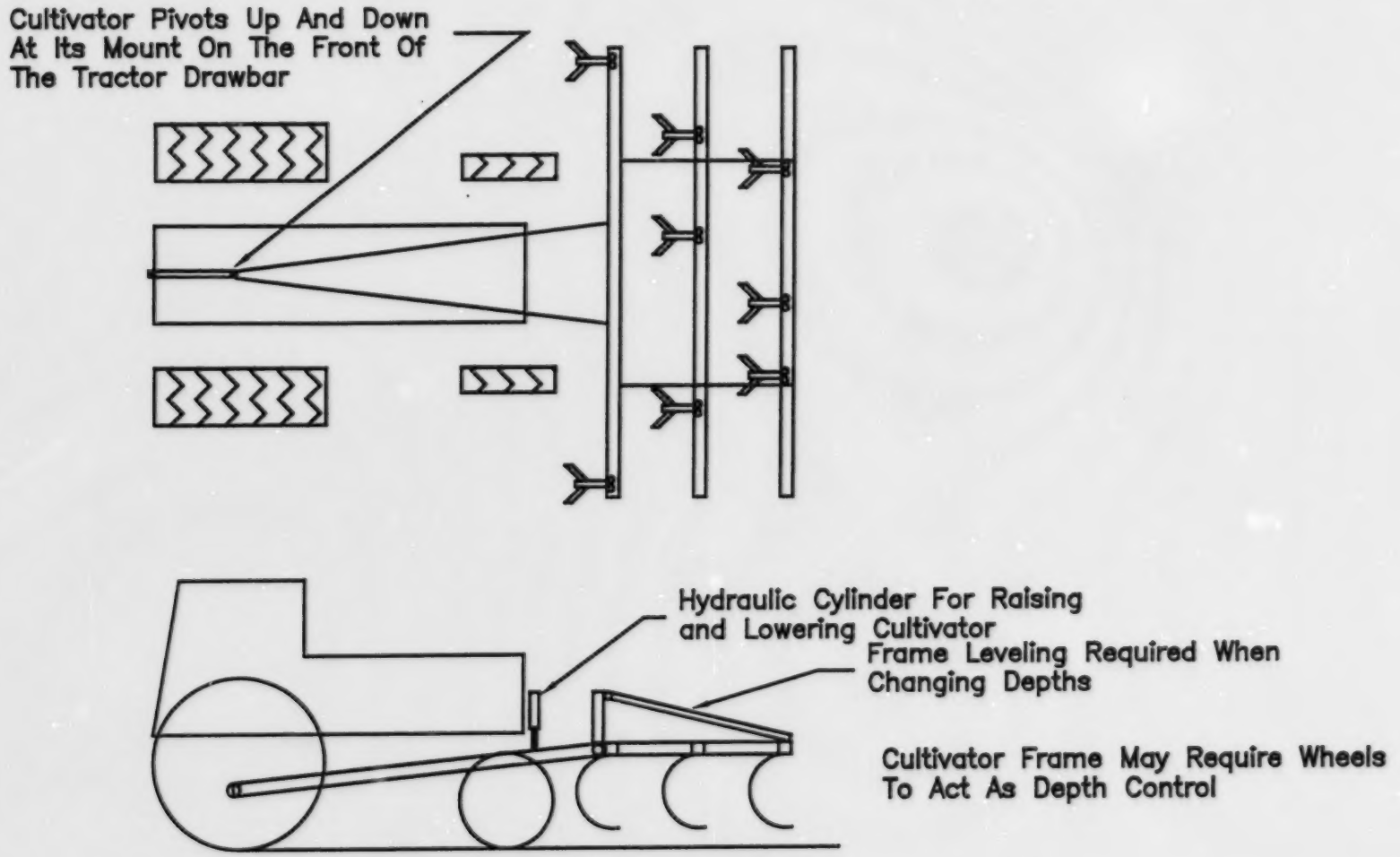
Cultivator Pivots Up And Down At Its Mount On The Front Of The Tractor Drawbar
Hydraulic Cylinder For Raising and Lowering Cultivator
Frame Leveling Required When Changing Depths
Cultivator Frame May Require Wheels To Act As Depth Control

Figure 1. Push Cultivator Mounted in Front of the Tractor

IMPERIAL UNITS; TOLERANCES UNLESS NOTED OTHERWISE ARE: FRACTIONS: ±1/16" X.X: ±0.05" X.XX: ±0.02" X.XXX: ±0.002" ANGLES: ±0.5°	PAMI Prairie Agricultural Machinery Institute P.O. Box 1150 Humboldt, Saskatchewan	TITLE:		MATERIAL:	
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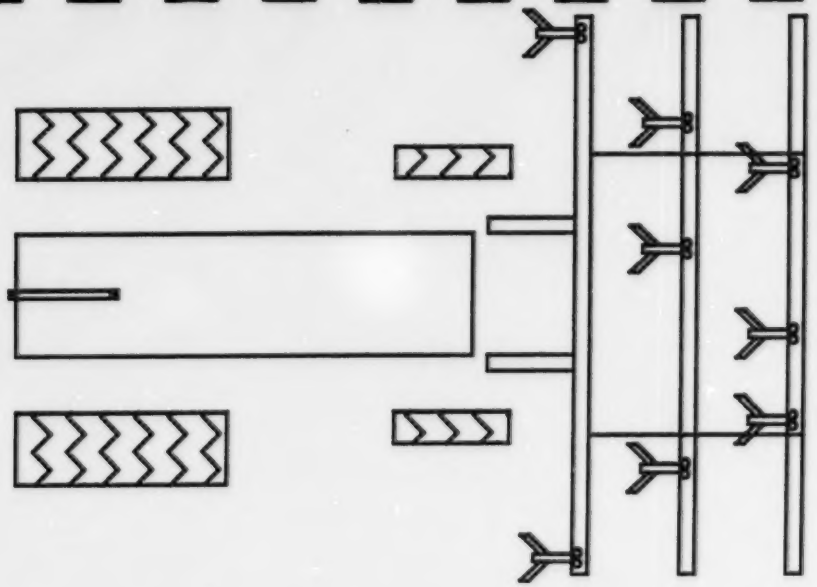

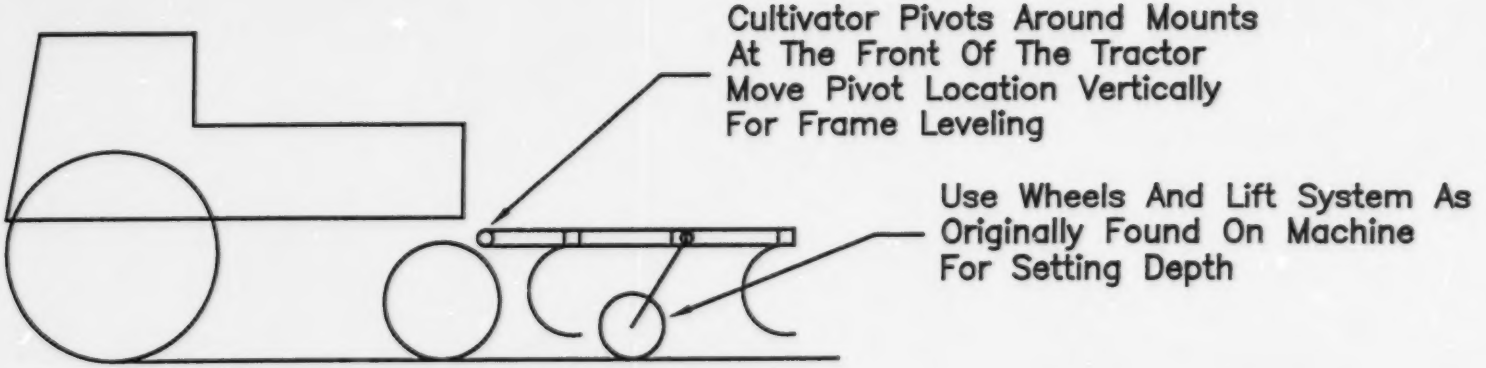
Cultivator Pivots Around Mounts
At The Front Of The Tractor
Move Pivot Location Vertically
For Frame Leveling
Use Wheels And Lift System As
Originally Found On Machine
For Setting Depth

Figure 2. Push Cultivator Mounted in Front of the Tractor

IMPERIAL UNITS; TOLERANCES UNLESS NOTED OTHERWISE ARE: FRACTIONS: ±1/16" X.X: ±0.05" X.XX: ±0.02" X.XXX: ±0.002" ANGLES: ±0.5°	PAMI Prairie Agricultural Machinery Institute P.O. Box 1150 Humboldt, Saskatchewan	TITLE:		MATERIAL:	
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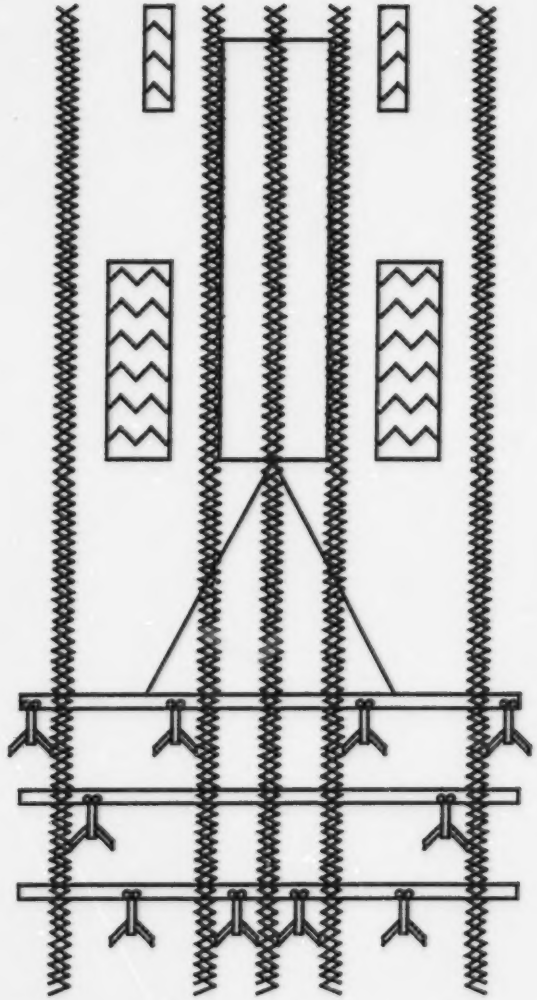

Figure 3. Cultivating with 18 in. Row Space on a 12 ft. Machine

IMPERIAL UNITS; TOLERANCES UNLESS NOTED OTHERWISE ARE: FRACTIONS: ±1/16" X.X: ±0.05" X.XX: ±0.02" X.XXX: ±0.002" ANGLES: ±0.5°	PAMI Prairie Agricultural Machinery Institute P.O. Box 1150 Humboldt, Saskatchewan	TITLE:		MATERIAL:	
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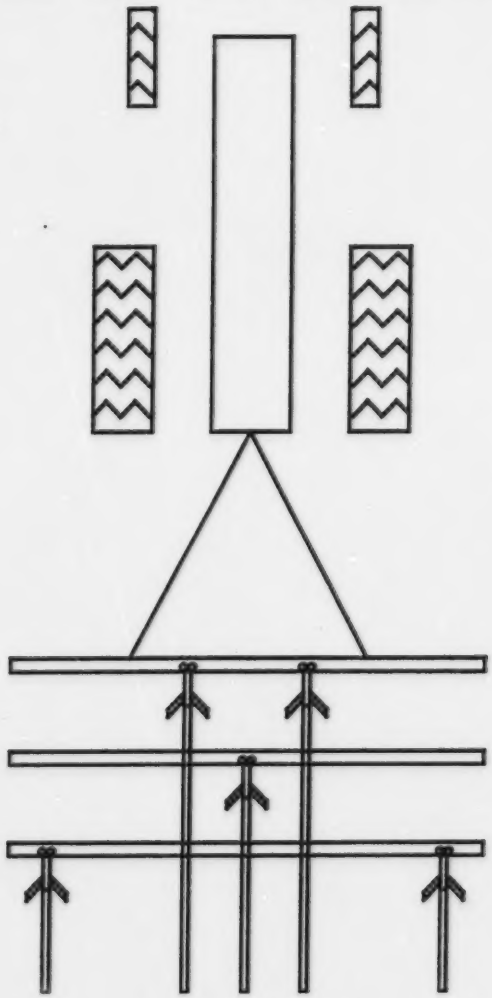

Figure 4. Using Cultivator to Mark the Seeding Rows

IMPERIAL UNITS; TOLERANCES UNLESS NOTED OTHERWISE ARE: FRACTIONS: ±1/16" X.X: ±0.05" X.XX: ±0.02" X.XXX: ±0.002" ANGLES: ±0.5°	PAMI Prairie Agricultural Machinery Institute P.O. Box 1150 Humboldt, Saskatchewan	TITLE:		MATERIAL:	
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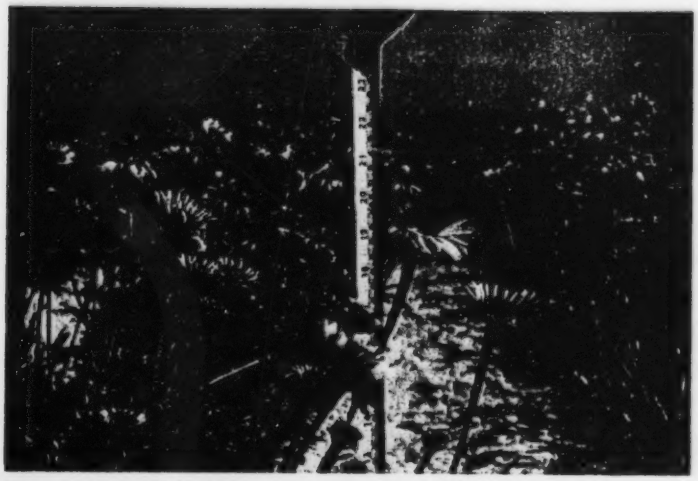

Figure 5. Height of Crop.

Figure 6. Williams Tool System – Type of Manual Guidance System using Guide Wheels.

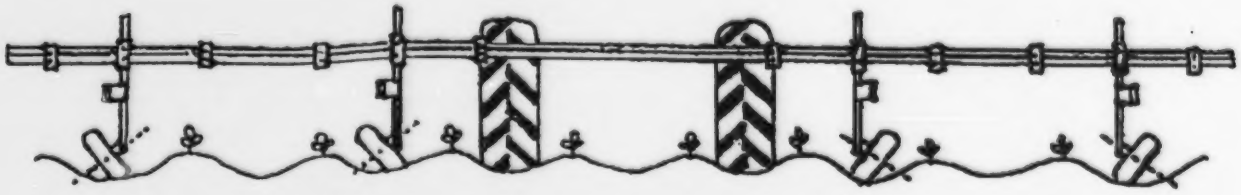

Figure 7. Williams Tool System – Type of Manual Guidance System using Guide Wheels.

Figure 8. Operator Steering Cultivator.
(For safety, the operator should be located at the rear of the cultivator facing direction of travel)

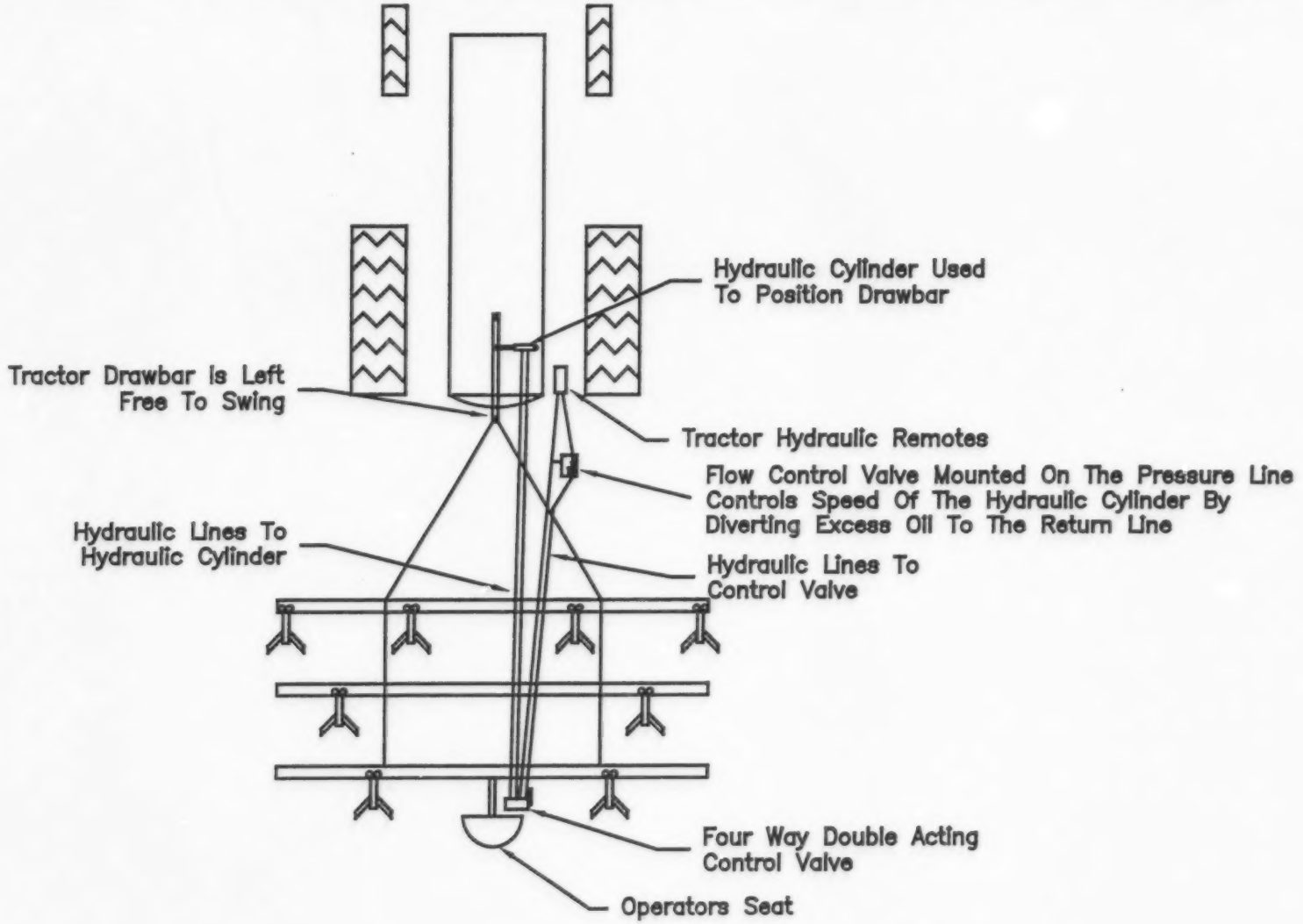

Figure 9. Layout of Hydraulic Guidance System

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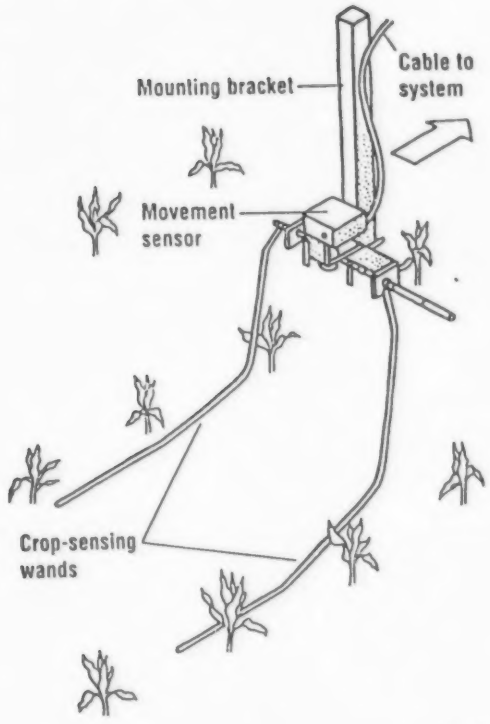

Figure 10. Typical Automatic Guidance System.

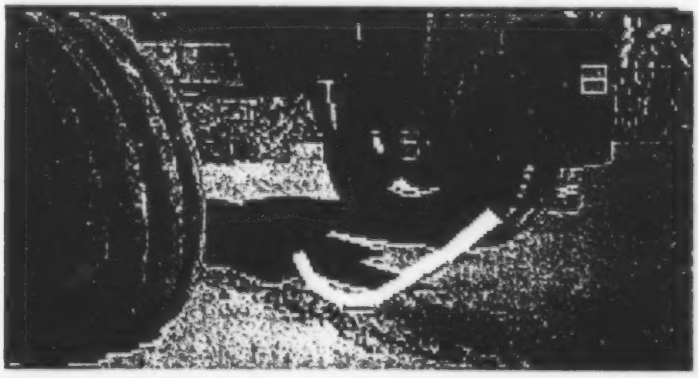

Figure 11. Tri-R Innovation System used for Seeding and Cultivating the Steers Tractor - Planting.

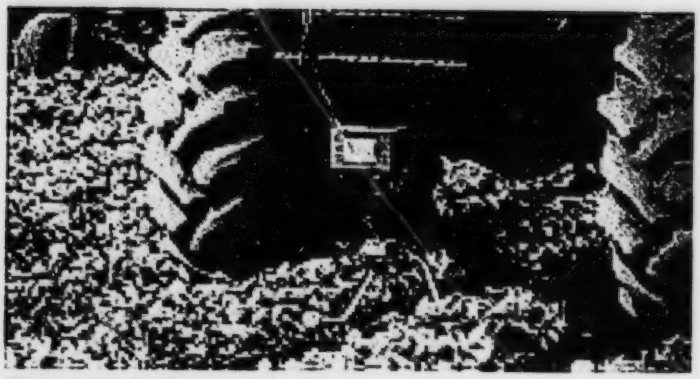

Figure 12. Tri-R Innovation System used for Seeding and Cultivating the Steers Tractor - Cultivating.

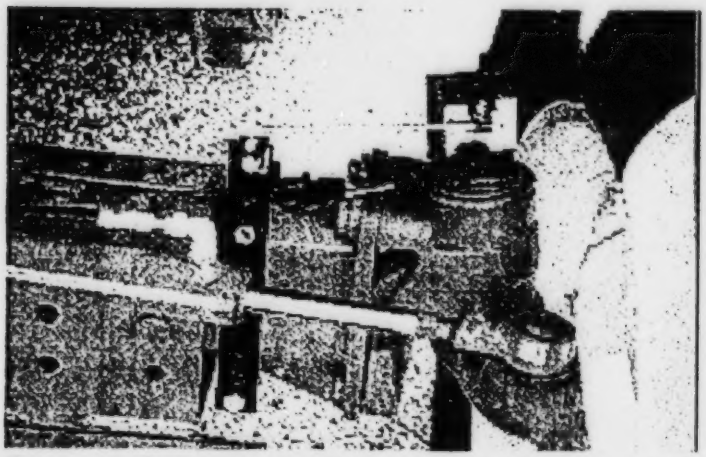

Figure 13. Tri-R Innovation System used for Seeding and Cultivating the Steers Tractor – Feedback Sensor mounts onto Steering Axle.

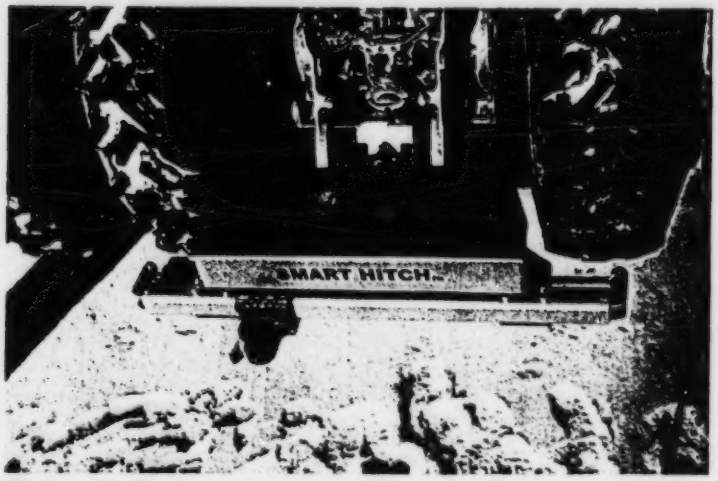

Figure 14. Guidance System that steers the Cultivator with Smooth Hitch System.

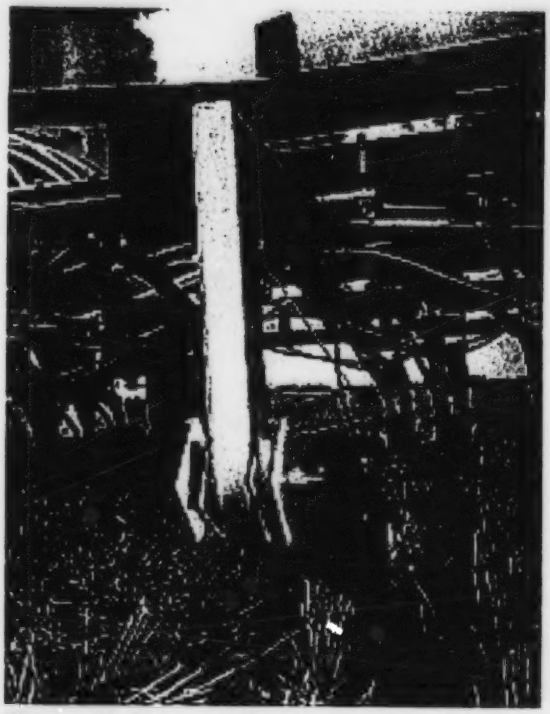

Figure 15. Guidance System that steers the Cultivator with Smooth Hitch System.

APPENDIX II

Appendix II

Power Requirements

Draft Characteristics: Draft requirements have been measured on several full-scale cultivators in various field conditions over the past years. Average draft requirements have been determined from these requirements.

Draft requirements for the same cultivator, in the same field, may vary by as much as 30% in two different years due to changes in soil conditions. Variations in soil conditions affect draft much more than variations in machine make, making it difficult to measure any significant draft differences between make of cultivators.

Since there is little or no draft differences between machines, PAMI has averaged the results obtained over the years and has used these to determine tractor size requirements.

Recommended Tractor Size: The following tables show tractor PTO power required to pull cultivators in various conditions at the given depths and speed. Tractor power requirements have been adjusted to include a tractive efficiency of 80% in primary and 70% in secondary tillage and represent a tractor operating be used along with the maximum PTO ratings, as determined by Nebraska tests or as presented by the tractor manufacturer, to select the appropriate tractor. Higher power will be required in hills or in heavy soils. Cultivators with marked differences in spacing, number of rows, or configuration may require more or less power.

Recommended tractor size may be determined by selecting the required horsepower per foot from the appropriate table and multiplying by the amount of tillage width of the cultivators (i.e. exclude the width of the crop). For example, in primary tillage at 2 in. (150 mm) and 4 mph (6.4 km/h), 2.7 hp/ft (6.6 kW/m) is required. Therefore, for a 12 ft (3.6 m) cultivator in those conditions, 33 PTO hp (164 kW) is recommended.

Table 1. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Primary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
2	(50)	2.7	(6.6)	3.4	(8.3)	4.1	(10.0)
3	(75)	3.8	(9.3)	4.8	(11.7)	5.8	(14.2)
4	(100)	4.9	(12.0)	6.1	(14.9)	7.4	(18.1)
5	(125)	6.0	(14.7)	7.5	(18.4)	9.0	(22.0)

Table 2. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Secondary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
2	(50)	2.3	(5.6)	3.0	(7.3)	3.6	(8.8)
3	(75)	3.4	(8.3)	4.3	(10.5)	5.2	(12.7)
4	(100)	4.5	(11.0)	5.6	(13.7)	6.8	(16.6)
5	(125)	5.5	(13.5)	7.0	(17.1)	8.4	(20.6)

APPENDIX III

Appendix III

Manufacturers' Addresses

Manual Guidance Systems
Alloway Ind.
1330 43rd ST NW
Fargo, ND 58102
Phone: (800) 289-3067
Fax: (701) 282-7043

Canadian Dealer –
Milliken Farm Supplies Ltd.
5614 64 St
Taber, AB T1G 1Y8
Phone: (403) 223-4437
Fax: (403) 223-3411

Kroeker Machinery Sales
PO Box 1026
Winkler, MB R6W 4B1
Phone: (204) 239-4947

Bezzerides Bros. Inc.
PO Box 211
Orosi, CA 93647
Phone: (559) 528-3011
Fax: (559) 528-9343

Canadian Dealer –
John C Graham Co Ltd.
88 Erie St N
Leamington, ON N8H 2Z6
Phone: (519) 326-5051

Bush Hog Corp.
2501 Griffin Ave
Selma, AL 36702-1039
Phone: (334) 872-6261
Fax: (334) 872-6262

Saskatchewan Dealers -
Ferre' Farm Equipment
601 Park Rd
Zenon Park, SK
Phone: (306) 767-2202

Harper Implements (1985) Ltd.
120 Simpson Ave
Birch Hills, SK
Phone: (306) 749-3588

Fennig Farm Equip Ltd.
4301-52nd St
Lloydminster, SK
(306) 825-4871

Nykolaishen Farm Equip Ltd.
Hwy 8 South
Kamsack, SK
Phone: (306) 542-2411

Oxbow Farm Centre Ltd.
Hwy 18 West
Oxbow, SK
Phone: (306) 483-2244

Farm World Equipment Ltd.
Kinistino, SK
Phone: (306) 864-2522

Farmfax Mgmt System, Inc.
Highway #6 North
Raymore, SK
Phone: (306) 746-2271

Sagal Bros Sales Ltd.
1030 N Service Rd
Moose Jaw, SK
Phone: (306) 692-7844

Agratec Int'l Ltd.
Hwy 318
Carnduff, SK
Phone: (306) 482-3377

Triod Supply (NB) Ltd.
2621 98th St
North Battleford, SK
Phone: (306) 445-1200

Moody's
Hwy 14
Perdue, SK
Phone: (306) 237-4272

Cropper Motors Inc.
Hwy #6 North
Naicam, SK
Phone: (306) 874-2011

Wagar Farm Equipment Ltd.
Hwy 9 & 49 West
Sturgis, SK
Phone: (306) 548-2966

Glenmor Grain Systems Ltd.
Old Hwy 2 South
Prince Albert, SK
Phone: (306) 764-2325

Ofe Farm Equip Ltd.
Hwy 15 West
Outlook, SK
Phone: (306) 867-8328

Hibbard Equip Ltd.
Main Street
Minton, SK
Phone: (306) 969-2133

Armstrong Imp (1993) Ltd.
625 N Railway St W
Swift Current, SK
Phone: (306) 773-7281

Dupont Holdings Ltd.
North Service Rd, Hwy 1
Swift Current, SK
Phone: (306) 773-8682

Wawota Garage Ltd.
Hwy 28 East
Wawota, SK
Phone: (306) 739-2377

FSH Inc.
PO Box 654
Henderson, NE 68371
Phone: (402) 723-4468

Roll-A-Cone Mfg. & Dist.
Box 23 R2
Tulia, TX 79088
Phone: (806) 668-4722
Fax: (806) 668-4725

Sprayrite Mfg. Co.
PO Box 3289
West Helena, AR 72390
Phone: (870) 572-6737
Fax: (870) 572-6730

Automatic Guidance Systems
AGCO
4830 River Green Parkway
Duluth, GA 30136
Phone: (770) 813-9200
Fax: (770) 813-6038
www.AGCOCORP.com

Canadian Dealer -
Avenue Farm Machinery Ltd.
1521 Sumas Way
Box 369
Abbotsford, BC V2S 4N9
Phone: (604) 864-2665

Buffalo Farm Equipment
PO Box 848
Columbus, NE 68602-0848
Phone: (402) 564-3244
Fax: (402) 562-6112
www.buffalofarm.com

Canadian Dealer -
Apollo Distributing Corp
Highway 1 E
Emerald Park, SK
Phone: (306) 781-2644
Fax: (306) 781-2599

Automatic Equipment Manufacturing
One Mill Road, Industrial Park
Pender, NE 68074
Phone: 402) 385-3220
www.automaticag.com

Lincoln Creek Mfg.
RD 1 Box 41
Phillips, NE 68865
Phone: (402) 886-2483
Fax: (402) 886-2274

Sukup Mfg. Co.
Box 677
Sheffield, IA 50475-0677
Phone: (515) 892-4222
Fax: (515) 892-4629
www.sukup.com

Canadian Independent Representative -
Jim Armstrong
Phone: (519) 657-1787

Straw Track Mfg. Inc.
PO Box 871
Whitewood, SK S0C 5C0
Phone: (306) 735-2208
Fax: (306) 735)2349
Email: strawtrack@sk.sympatico.ca

Tri-R Innovations, Inc.
628 S. Sangamon Ave.
Gibson City, IL 60936
Phone: (217) 784-8495

SUNCO Marketing (Acura-Trak)
4320 Rodeo Rd
North Platte, NE 69101-1007
Phone: (308) 532-2146
Email: sunco@nponline.net

Canadian Dealer -
Grower Supply Ltd.
401 1st St N
Vauxhall, AB T0K 2K0
Phone: (403) 654-2223
Fax: (403) 654-2414

APPENDIX IV

Appendix IV

Research Update

PAMI
www.pami.ca
Research Update
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746

Converting a Field Cultivator for Row Crop Use

Find an old field cultivator and convert it for your new row crops!

Are you looking for ways to diversify your farm production?

Many producers in Saskatchewan are looking to row crops, and particularly herbs and spices as alternatives, but need cultivation equipment suited to growing row crops. But you may not need to buy new equipment—you may be able to modify an inexpensive older machine yourself.

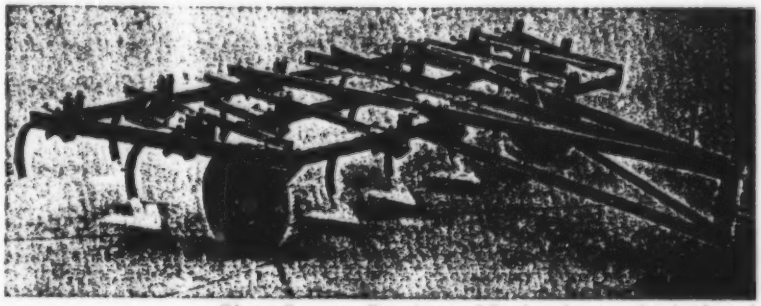

Photo Source: Province of Saskatchewan Agricultural Machinery Administration

Some degree of tillage is required for herb and spice production, either due to organic requirements or due to a lack of registered herbicides. Some producers prefer the small single row tillers or three-point hitch equipment more commonly found in market gardens, while others would rather use a larger cultivator. In either case, older hitch-drawn cultivators are plentiful on the Prairies, and serve as excellent candidates for conversion to row-crop use.

To find out more, PAMI contacted herb growers to gather information on their use of tillage equipment and to find older cultivators that had already been converted into row crop machines.

At a Glance

Most older field cultivators are suitable for modification for row cropping. Your specific needs will be determined by the crops you grow and the tractor power available.

Factors you'll want to consider include row spacing and row spacing flexibility, whether you need a towed or tractor mounted unit, frame size and layout, ease of levelling, ease of moving, removing, and replacing shanks, overall machine condition, and the robustness of the shanks.

You may also want to add some type of guidance system to keep the machine on track, and prevent shovels from wandering into crop rows.

Choosing a Cultivator

No one make of machine is necessarily better suited to conversion then another. Growers must assess their own situation regarding crops, conditions, tractor to be used, availability of a second operator, etc. and then evaluate the available cultivators to determine how well suited they are for conversion.

Cultivator Mounting Position

Cultivators can be either drawn, front mounted or three-point hitch mounted. What follows are some pros and cons of each type.

Drawn Cultivators: Hitch movement and the length of the drawbar can cause side to side movement of the cultivator. This can be to the operator's advantage if guide wheels are used, allowing slight lateral shifts of the machine to line up with the rows. Drawn cultivators typically don't need any hitch modifications.

However, a drawn cultivator is positioned far behind the tractor operator's position, making it hard to see crop damage or make minor steering changes to prevent crop damage. A cultivator steering mechanism may be needed with either a second operator riding on the cultivator or an automatic guidance system to make tracking adjustments as the cultivator travels down the rows.

Three-point Hitch Mounts: Farmers with three-point hitch equipped tractors will appreciate having the tillage tool closer to the operator's position, improving visibility and allowing more positive tracking control. However, tractor steering corrections amplify movement of rear mounted cultivators in the opposite direction, threatening crop rows. Shorter cultivators work better with these systems and depending on row space, a single or double rank machine may be the best.

Front Mounted (Push Style): Mounting the cultivator in front of the tractor and pushing it provides the operator with good visibility and manoeuvrability while cultivating (Figure 1), eliminating additional guidance systems or a second operator. Although not a traditional position for a pulled machine, the concept appears to have merit, especially for the smaller size of older cultivators.

Two concept drawings (Figure 1 and 2) have been included to show some possibilities. Either a push pole or a three-point lift device on the front of the tractor could be used to control the cultivator. The largest effective cultivator width will be a function of tractor weight, as heavy forces from stones applied to the outer ends of the cultivator may push the tractor around.

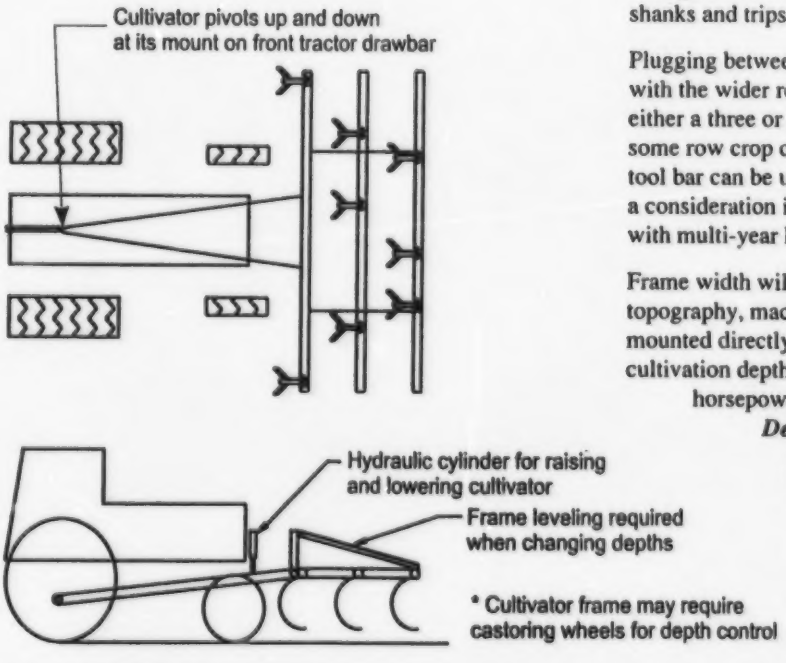
Cultivator pivots up and down
at its mount on front tractor drawbar
Hydraulic cylinder for raising
and lowering cultivator
Frame leveling required
when changing depths
* Cultivator frame may require
castoring wheels for depth control

Figure 1: Push cultivator mounted in front of tractor and connected to the rear hitch point.

Determine Row Spacing Requirements

Determine the row space requirements for the crops you are growing and will grow. Having moveable shanks allows for maximum flexibility. Ask yourself if the crop fills in towards the centre of the rows, and how much you will need to adjust the shank or tool width to accommodate this growth. Would a knock-on style opener by justified? The crop row spacing may need to be altered in the middle of the machine to accommodate your tractor tire spacing (Figure 3). This spacing may also be affected by your seeding equipment. Do you use a single row seeder or multiple row seeder with spacing that matches your cultivator? If the row crop cultivator will be used for seeding by adding a seed box on top, then tillage shanks with a seed opener should be installed where needed. This arrangement can also be used for marking rows when seeding one row at a time. The tillage shovels can be moved to the location of the seed rows and serve the dual purpose of marking the field (Figure 4).

Frame Size or Layout

Field cultivators were originally designed to be strong enough to work the soil at row spaces of 12 in. or less, with a full set of shovels. In row cropping you will be using at most only 2/3 of the shanks, so frame size or strength isn't a big concern. Make sure at least 2/3 of the shanks and trips are in good shape.

Plugging between the shanks shouldn't be a problem with the wider row spacing required for row crops, so either a three or four rank machine should be fine. In some row crop cases a double rank or even single rank tool bar can be used. Frame to ground clearance may be a consideration if you are tilling a tall crop, as is the case with multi-year herb crops (Figure 5).

Frame width will be a consideration depending on topography, machine levelling and whether it is drawn or mounted directly on the tractor. Frame width, tool type, cultivation depth and ground speed will all affect tractor horsepower requirements (See the section entitled ***Determining Horsepower Requirements***).

Some additional considerations for machine selection include:

- How easy is the machine to level front to back and side to side, and are all the adjustments still working?
- Are the remaining shanks still fairly tight especially sideways so they don't wander into the crop?

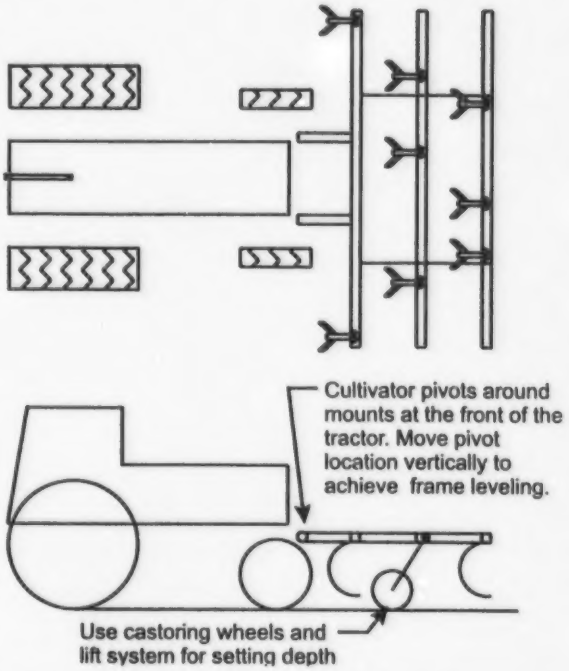
Cultivator pivots around mounts at the front of the tractor. Move pivot location vertically to achieve frame leveling.
Use castoring wheels and lift system for setting depth

Figure 2: Push cultivator mounted in front of tractor.

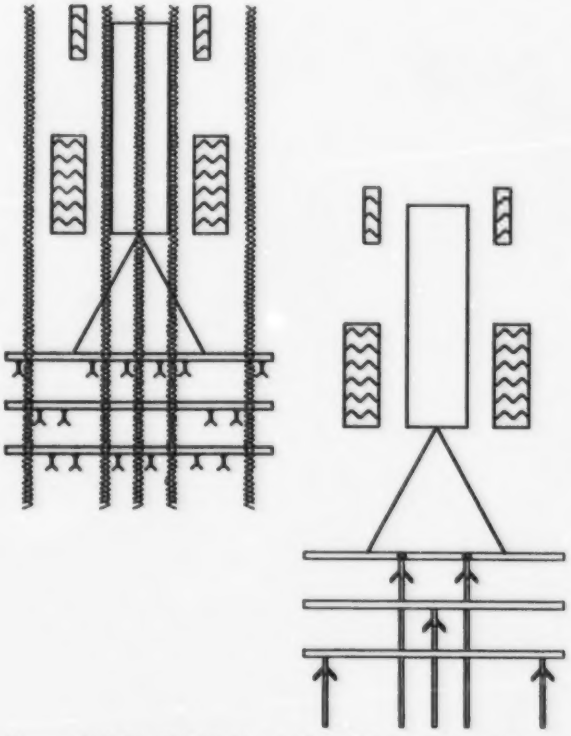

Figure 3 (left): Cultivating with an 18 in row spacing on a 12 foot machine. Figure 4 (right): Tillage shovels can be moved to the location of the seed rows and serve the dual purpose of marking the field.

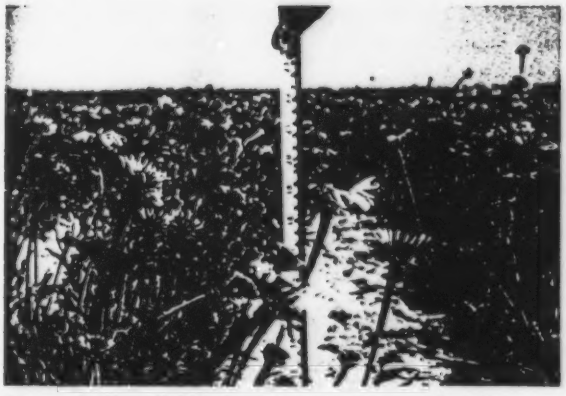

Figure 5. Crop height is an important consideration when converting a field cultivator to row crop use. PAMI photo.

• Ease of movement of the shanks, including sliding from side-to-side and removal and replacement on the frame, are major considerations especially if you are working in different crops and row spacing.

• How heavy are the shanks? Lighter shanks may wander more due to side stone impact or when a shank is working against a soil ridge.

Keeping Your Cultivator On Track

Tractor mounted cultivators, whether front or rear mounted, are guided by steering the tractor. Simple pointer type markers attached to the tractor can be used to assist the driver in this process.

But keeping your tractor-drawn cultivator on track in the field can be more difficult. When the cultivator is towed behind the tractor there is some lag time and difficulty ensuring tillage up to but not into the growing crop.

Guidance systems can help operators get close to the crop and reduce the need for hand weeding. Keep reading to find out more about different control systems to keep a towed cultivator in line.

Guide Wheels

Guide wheels are usually found on market garden, three-point hitch style equipment, and in principle should work well on towed machines also.

Guide wheels adjust cultivator tracking by riding in guide furrows or against ridges usually made at seeding. These systems allow the cultivator to move sideways, in relation to the tractor, within the limits of the hitch. By leaving the drawbar free to swing from side to side, the tractor simply pulls the cultivator and is only used to guide it in a general direction.

Encountering rocks, wind and rain erosion may affect guide wheel performance with a towed cultivator, though we did not observe any of these problems. A guide wheel system may be more suited to crops that are harvested yearly rather than crops that require a 2 or 3 year growing cycle, as ridges or furrows created during seeding will disappear over time and provide less direction to the cultivator. In addition, erosion, plant roots and other factors will become more prominent over time and may negatively affect cultivator tracking. The Williams Tool System uses guide wheels as a way of manually guiding the cultivator (Figure 6).

Hydraulic Guidance with Operator Assist

Charlie Coleman of McAuley, Manitoba, and row crop farmers in the United States have adapted and used variations of hydraulic guidance systems with tow behind cultivators. An operator sitting on the cultivator operates a hydraulic valve, which controls a cylinder connected to the swinging draw bar. By adjusting the valve, the operator can move the draw bar left or right, adjusting the cultivator to accommodate closer tillage to the crop (Figure 7).

This modification is achieved by mounting a hydraulic cylinder underneath the tractor, approximately halfway between the draw pin and the front mounting pin on the drawbar. The cylinder rod end is positioned on the drawbar where the cylinder stroke in and out is matched to or greater than the sideways swing of the drawbar. The back of the cylinder is then mounted perpendicular to the draw bar when the drawbar is in its 'straight back' position.

A hydraulic 2-way valve is quick coupled into one of the remote circuits of the tractor. The hydraulic valve must be matched to either the open centre or closed centre system of the tractor. A standard 4 in. agricultural cylinder with an 8 in. stroke will work fine. A flow control valve on the hydraulics may be required to reduce the reaction speed of the cylinder to eliminate rapid drawbar whipping. The cultivator operator, by operating the valve, steers the cultivator to ensure proper tillage tracking. The hydraulics required for this system cost about $300 plus hoses. A basic layout of the hydraulic guidnce system appears in Figure 8.

When using this system it's easiest for the cultivator operator to line up the cultivator with a marker located above one row, rather than line up a shank with a buried shovel that is travelling close to the crop. The marker can be anything that hangs above one row of crop to aid in positioning. A disk used to hill the crop is easier to keep in line, as it is more visible than a shovel. The seat on the cultivator should be located at the rear of the machine for safety and ease of operation. The tractor

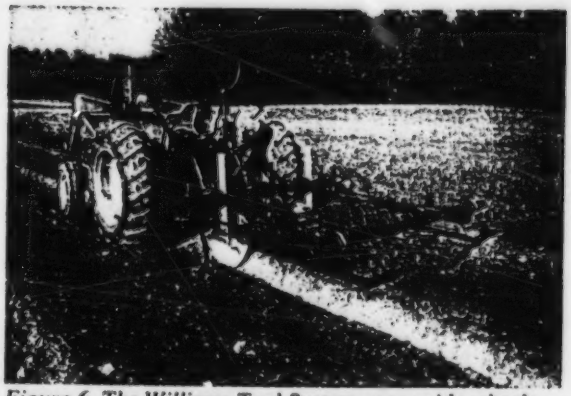

Figure 6. The Williams Tool System uses guide wheels as a way of manually guiding the cultivator. Market Farm Implement Catalogue photo, used by permission.

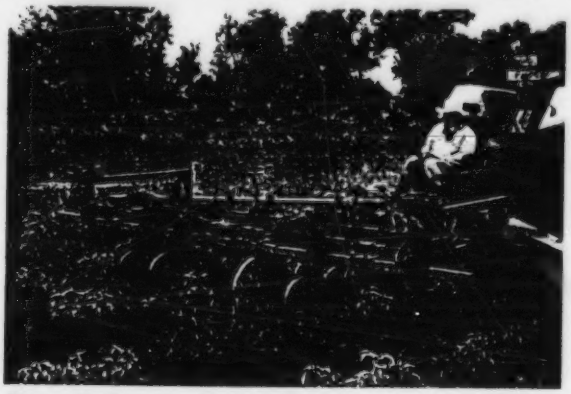

Figure 7. Operator Steered Cultivators are safer if the operator is positioned at the rear of the cultivator, facing direction of travel. PAMI photo.

operator then need only concentrate on tractor travel between rows.

Readers should be aware that these systems pose some risk to the operator from dust, falling off the machine, or potential injury due to shank breakage. Minimize hazards by carefully positioning the seat, using a seat belt, and wearing a suitable dust mask.

Automatic Guidance Systems

The automatic guidance system eliminates the need for a second operator on the cultivator. These systems use sensors to control the movement of the cultivator by either moving the hitch or by steering the tractor, and can also be used for guidance during seeding.

One type uses wire or plastic wands that run along the soil surface near the base of the plant. The wands rotate around a pivot point when contacting the crop, activating a micro switch and sending a signal to a hydraulic cylinder used to steer the unit (Figure 10). However, residue, protruding dirt or weed growth can compromise accurate row crop sensing.

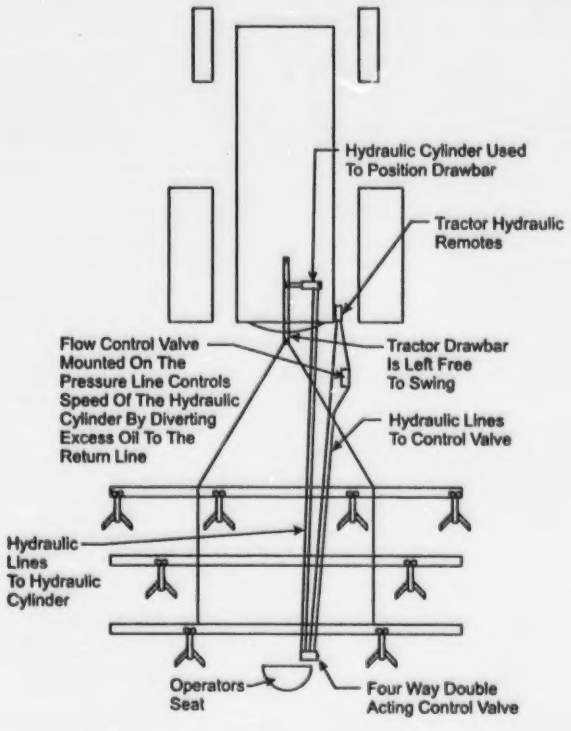
Hydraulic Cylinder Used To Position Drawbar
Tractor Hydraulic Remotes
Flow Control Valve Mounted On The Pressure Line Controls Speed Of The Hydraulic Cylinder By Diverting Excess Oil To The Return Line
Tractor Drawbar Is Left Free To Swing
Hydraulic Lines To Control Valve
Hydraulic Lines To Hydraulic Cylinder
Operators Seat
Four Way Double Acting Control Valve

Figure 8: Concept for operator assist, hydraulically controlled guidance system.

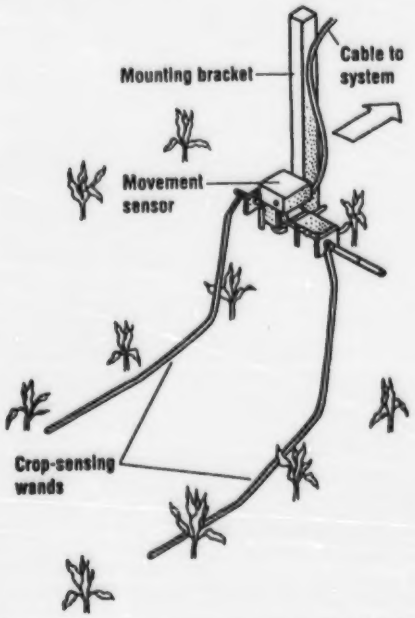

Figure 9. A guidance system using wire or plastic wands that run along the soil surface near the base of the plant. The wands rotate around a pivot point when contacting the crop, activating a micro switch and sending a signal to a hydraulic cylinder used to steer the unit. (Source: Steel in the Field,© 1997, The Sustainable Agriculture Network, used by permission)

Another system uses a sensor mounted at the front of the cultivator that straddles the crop, controlling the direction by sensing changes in the dirt height near the crop row. Sophisticated systems allow you to adjust the sensitivity so the system doesn't overreact to foreign obstacles. See Figures 11 - 15 for a pictorial overview of automated guidance systems.

None of the mentioned guidance systems, manual or automatic, have been evaluated by PAMI, and PAMI is not endorsing the use of any particular system.. Producers should investigate cost, performance and reliability before purchasing of these systems. See the section entitled ***Manufacturer's Addresses*** for contact information.

Wrap-up

While towed cultivators can be modified for three-point hitch or front attachment (and there may be advantages to doing this), we were not able to find any examples of such conversions. Expect a certain amount of trial and error work if you are attempting a three-point hitch or front-mount conversion.

Towed cultivators have been successfully adapted for row crop use in many instances. Your need for a guidance system will depend on your individual needs.

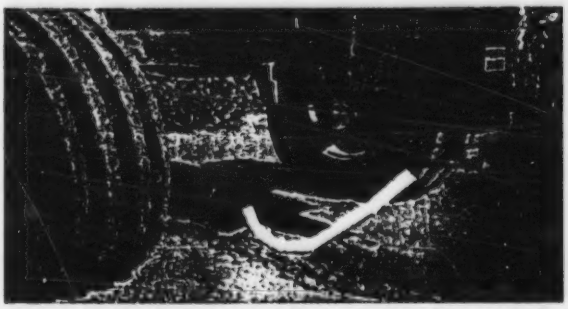

Figure 10. Tri-R Innovation System steers the tractor for seeding and cultivating (Planting operation shown here) Photo Source: Company Literature

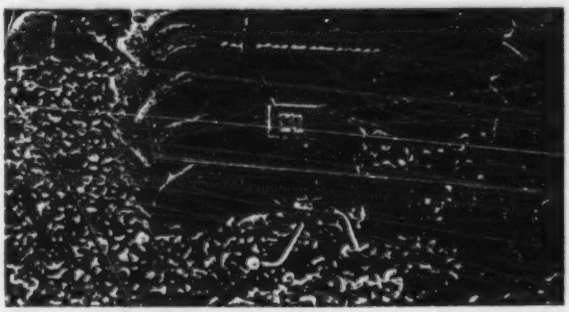

Figure 11. Tri-R Innovation System steers the tractor for seeding and cultivating (Cultivating operation shown here). Photo Source: Company Literature

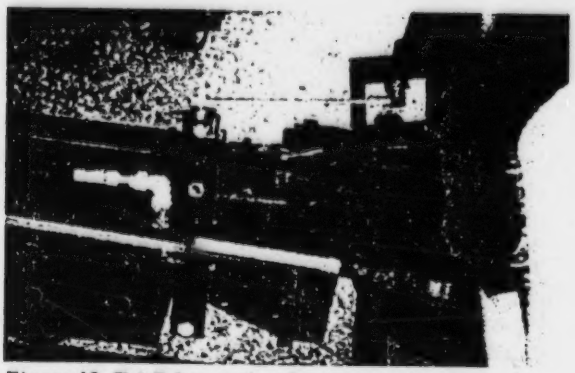

Figure 12. Tri-R Innovation System steering control – feedback sensor mounts onto steering axle. Photo Source: Company Literature

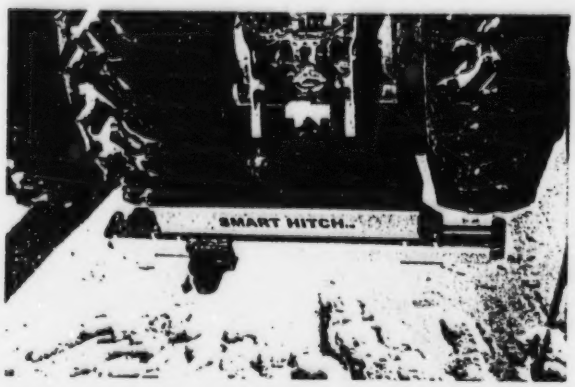

Figure 13. The Smart Hitch Guidance System steers the cultivator from the rear of the tractor. Photo Source:Smart Hitch photo, used by permission.

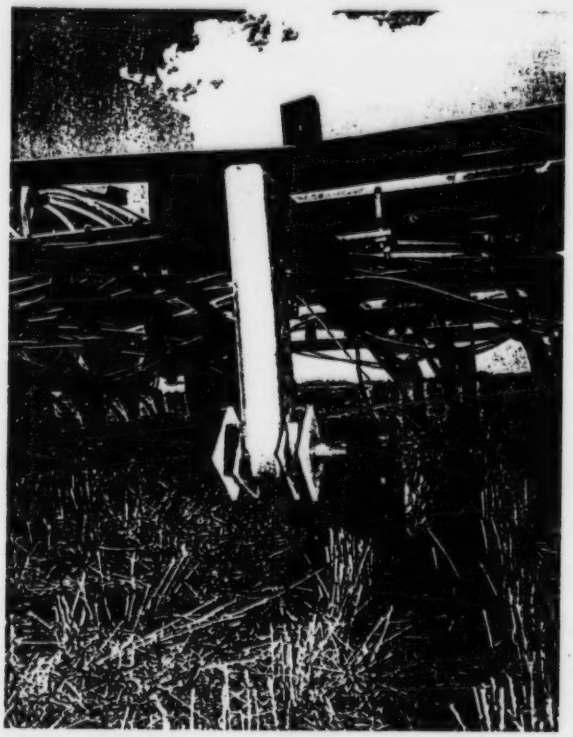

Figure 14. The Smart Hitch Guidance System mates to a steering mechanism on the cultivator. Photo Source: Western Producer/Michael Raine; Used by permission.

Herbs and Spices in Saskatchewan

Fast Facts:

- *The Saskatchewan Herb and Spice Association (SHSA) has about 300 members.*
- *Herb and spice production is just beginning to become mechanized, but is still a labour intensive operation. Machinery is being developed at the moment.*
- *There are about thirty different varieties of medicinal plants grown in Saskatchewan. These include three of the nine varieties of echinacea. Currently most commercial echinacea production is angustifolia.*
- *Some of the other herb varieties grown are St. John's wort, valerian, burdock, fireweed or willowherb, milk thistle, basil, chamomile and calendula.*
- *Extracts of fireweed are used in the cosmetic industry. Fytokem contracts both wildcrafted and commercial grown production.*

For more information, contact:

Saskatchewan Herb and Spice Association
Box 124
Sintaluta Sask.
S0G 4N0
Ph: 1-306-727-4917,
Fax: 1-306-727-2226

Determining Power Requirements

Draft Characteristics

Over the years, PAMI has measured the draft requirements of numerous full-scale cultivators in various field conditions. These measurements can be used to determine average draft requirements.

Draft requirements for the same cultivator in the same field may vary by as much as 30% in two different years due to changes in soil conditions. Variations in soil conditions affect draft much more than variations in machine brand, making it difficult to measure any significant draft differences between brands of cultivators.

PAMI's averaged results are a useful tool in determining tractor size requirements.

Recommended Tractor Size

Tables 1 and 2 show the tractor PTO power required to pull cultivators in various conditions at the given depths and speeds. Tractor power requirements have been adjusted to include a tractive efficiency of 80% in primary and 70% in secondary tillage and represent a tractor operating at 80% of maximum PTO power on a level field. These power requirements can be used along with the maximum PTO ratings, as determined by Nebraska tests or as presented by the tractor manufacturer, to select the appropriate tractor. Higher power will be required in hills or in heavy soils. Cultivators with marked differences in spacing, number of rows, or configuration may require more or less power.

Recommended tractor size may be determined by selecting the required horsepower per foot from the appropriate table and multiplying by the amount of tillage width (not crop width) of the cultivator. For example, in primary tillage at 2 in. (50 mm) and 4 mph (6.4 km/h), 2.7 hp/ft (6.6 kW/m) is required. Therefore, for a 12 ft (3.6 m) cultivator in those conditions, 33 PTO hp (25 kW) is recommended.

Table 1. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Primary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
		Hp/ft	(kW/m)	Hp/ft	(kW/m)	Hp/ft	(kW/m)
2	(50)	2.7	(6.6)	3.4	(8.3)	4.1	(10.0)
3	(75)	3.8	(9.3)	4.8	(11.7)	5.8	(14.2)
4	(100)	4.9	(12.0)	6.1	(14.9)	7.4	(18.1)
5	(125)	6.0	(14.7)	7.5	(18.4)	9.0	(22.0)

Table 2. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Secondary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
		Hp/ft	(kW/m)	Hp/ft	(kW/m)	Hp/ft	(kW/m)
2	(50)	2.3	(5.6)	3.0	(7.3)	3.6	(8.8)
3	(75)	3.4	(8.3)	4.3	(10.5)	5.2	(12.7)
4	(100)	4.5	(11.0)	5.6	(13.7)	6.8	(16.6)
5	(125)	5.5	(13.5)	7.0	(17.1)	8.4	(20.6)

PAMI wishes to thank the Agriculture Development Fund of Saskatchewan Agriculture and Food for its support in making this project possible.

Manufacturers Guide

Manual Guidance Systems

Alloway Ind.
1330 43rd ST NW
Fargo, ND 58102
Phone: (800) 289-3067
Fax: (701) 282-7043

Canadian Dealer –
Milliken Farm Supplies Ltd.
5614 64 St
Taber, AB T1G 1Y8
Phone: (403) 223-4437
Fax: (403) 223-3411

Kroeker Machinery Sales
PO Box 1026
Winkler, MB R6W 4B1
Phone: (204) 239-4947

Bezzerides Bros. Inc.
PO Box 211
Orosi, CA 93647
Phone: (559) 528-3011
Fax: (559) 528-9343

Canadian Dealer –
John C Graham Co Ltd.
88 Erie St N
Leamington, ON N8H 2Z6
Phone: (519) 326-5051

Bush Hog Corp.
2501 Griffin Ave
Selma, AL 36702-1039
Phone: (334) 872-6261
Fax: (334) 872-6262

Saskatchewan Dealers -
Ferre' Farm Equipment
601 Park Rd
Zenon Park, SK
Phone: (306) 767-2202

Harper Implements (1985) Ltd.
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Nykolaishen Farm Equip Ltd.
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Phone: (306) 542-2411

Oxbow Farm Centre Ltd.
Hwy 18 West
Oxbow, SK
Phone: (306) 483-2244

Farm World Equipment Ltd.
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Phone: (306) 864-2522

Farmfax Mgmt System, Inc.
Highway #6 North
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1030 N Service Rd
Moose Jaw, SK
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Agratec Int'l Ltd.
Hwy 318
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Triod Supply (NB) Ltd.
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Moody's
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Perdue, SK
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Wagar Farm Equipment Ltd.
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Glenmor Grain Systems Ltd.
Old Hwy 2 South
Prince Albert, SK
Phone: (306) 764-2325

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Hwy 15 West
Outlook, SK
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Hibbard Equip Ltd.
Main Street
Minton, SK
Phone: (306) 969-2133

Armstrong Imp (1993) Ltd.
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Swift Current, SK
Phone: (306) 773-7281

Dupont Holdings Ltd.
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Swift Current, SK
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Wawota, SK
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Fax: (814) 445-2238

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Fax: (806) 668-4725

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www.AGCOCORP.com

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Fax: (402) 562-6112
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Emerald Park, SK
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Pender, NE 68074
Phone: 402) 385-3220
www.automaticag.com

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Fax: (306) 735)2349
Email:
strawtrack@sk.sympatico.ca

Tri-R Innovations, Inc.
628 S. Sangamon Ave.
Gibson City, IL 60936
Phone: (217) 784-8495

SUNCO Marketing (Acura-Trak)
4320 Rodeo Rd
North Platte, NE 69101-1007
Phone: (308) 532-2146
Email: sunco@nponline.net

Canadian Dealer -
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401 1st St N
Vauxhall, AB T0K 2K0
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